Project Title: Beef Flavor Myology – Round 2: *Gluteus Medius, Infraspinatus, Rectus Femoris, Teres Major, and Triceps Brachii*

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Background

The beef industry has made improvements in tenderness over the years, resulting in flavor becoming a more important factor of consumer acceptability. Although flavor is commonly used as a singular and straightforward term, it is actually very complex and influenced by many factors. Marbling level, internal temperature, cooking method and other variables are related to the flavor development of meat. Additionally, due to variation in function and composition of different muscles, chemical characteristics of meat cuts vary. Therefore, various cuts of beef respond differently to different cooking methods and internal cooking temperatures.

Research has been performed for many of the most popular beef items to understand chemical and sensory characteristics of beef cuts. However, there are other, lesser consumed cuts of meat available in the marketplace that have not been studied as extensively. Additionally, changes in beef fabrication procedures have allowed specific muscles from the round and chuck to be separated and merchandized individually to deliver a more consistent product for consumers. These innovative beef cuts have not been analyzed with regard to how cooking method, marbling level, and internal temperature play a role in flavor and palatability.

The objective of this study was to evaluate the effects of quality grade, final internal temperature, and cooking method on sensory profile and volatile compound profile of five beef muscles: *rectus femoris, gluteus medius, infraspinatus, triceps brachii*, and *teres major*, in order to characterize sensory characteristics of these cuts.

Methodology

The treatment outline was derived from combinations of two quality grades (USDA Select, Upper 2/3 Choice/Top Choice), three cooking methods (grill, pan grill, oven roast), and three final internal temperatures (58.3°C, 70°C, and 80° C). Each unique treatment combination (n = 104) was replicated six times. Vacuum-packaged beef was purchased directly from a commercial beef harvest facility and transported to the Colorado State University Meat Laboratory where it remained under refrigerated conditions until it was fabricated into respective muscles at 14 days post-production. Samples were then frozen at -20°C until analysis.

Grill and pan grill cooking methods were applied to 2.54 cm steaks from all muscles. Oven roasting was applied to roasts from *rectus femoris, gluteus medius*, and *triceps brachii*, as well as whole muscles of *infraspinatus* and *teres major*. Additionally, whole *teres major* muscles were subjected to grill and pan grill treatments to represent common cooking practices for this cut. Each sample was analyzed by a trained sensory panel to provide ratings for flavor, tenderness, and juiciness factors. Six trained panelists evaluated twelve samples per panel; a total of 51

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panel sessions were conducted. Volatile compound analysis was performed on the same samples as were cooked for and served to trained panelists.

Findings

Although muscles were not compared directly, muscle differences did exist in regard to treatment effect. Degree of doneness had the greatest impact across all muscles evaluated. Higher final temperatures were related to higher beef ID, browned, and roasted notes in most muscles, but decreased tenderness in all muscles. Additionally, panelists detected greater amounts of bloody/serumy, metallic, and sour flavors in samples cooked to lower end-point temperatures. Cooking method affected flavor note ratings for all muscles, with oven roasting producing increased cardboardy, earthy/musty, and sour flavors. Perhaps the most evident difference related to cooking method was the more intense bitter and burnt flavors associated with pan grilling. Quality grade had a minimal impact on the muscles included in the study, but Top Choice samples of *triceps brachii* did present higher tenderness ratings than those from the Select grade. Association of volatile aromatic compounds with specific treatments also varied based on muscle. Overall, the 80°C and pan grilling treatments were related to the most volatile compounds compared to other treatments; primarily pyrazines, alkanes, and alkenes.

Implications

These results highlight the importance of understanding the properties of individual cuts in order to best use them to create a positive eating experience. In combination with previous research, this data will be used to develop a resource that characterizes sensory characteristics of lesser-utilized beef cuts. Not only will the beef industry benefit from greater knowledge about various cuts to improve carcass utilization, but foodservice operations as well as in-home cooks may be able to purchase more affordable items without sacrificing eating satisfaction.

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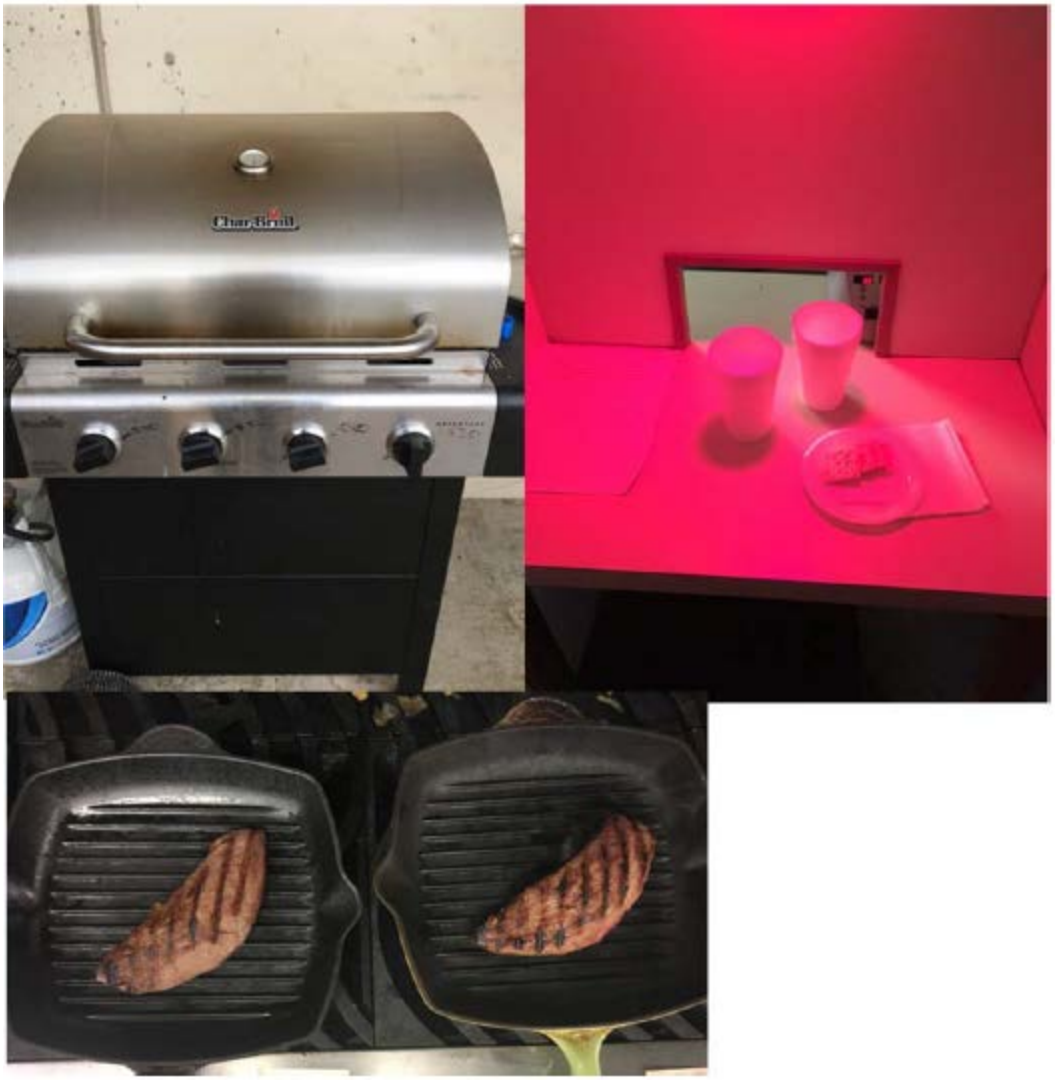

Figure 1. Collage of images from the study.

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Table 1. Trained sensory attributes[1] of USDA Select and Upper 2/3 Choice (Top Choice) beef *infraspinatus* cooked to three degrees of doneness using three cook methods.

	Quality Grade				Final Temperature (°C)					Cook Method				
Attribute	Select	Top Choice	SEM[2]	*P*— Value	58.3	70	80	SEM[2]	*P*— Value	Grill	Pan Grill	Oven Roast	SEM[2]	*P*— Value
Beef Flavor ID	6.93	6.92	0.10	0.93	6.66^{m}	6.78^{m}	7.33^{n}	0.12	<0.01	6.91^{xy}	7.18^{x}	6.68^{y}	0.12	<0.01
Browned	5.66	5.71	0.11	0.74	5.15^{m}	5.56^{m}	6.34^{o}	0.13	<0.01	5.59^{y}	6.39^{x}	5.08^{z}	0.13	<0.01
Roasted	6.51	6.48	0.11	0.81	6.32^{m}	6.47^{mn}	6.69^{n}	0.12	0.03	6.52	6.40	6.57	0.12	0.47
Bloody/Serumy	0.84	0.96	0.06	0.19	1.40^{m}	0.93^{n}	0.38^{o}	0.08	<0.01	0.96^{x}	0.69^{y}	1.06^{x}	0.08	<0.01
Metallic	0.98	1.01	0.06	0.65	1.09^{m}	1.03^{m}	0.86^{n}	0.07	0.02	0.87^{y}	1.03^{xy}	1.08^{x}	0.07	0.04
Fat-Like	1.55	1.61	0.07	0.61	1.60^{mn}	1.72^{m}	1.42^{n}	0.09	0.04	1.74	1.54	1.47	0.09	0.06
Umami	0.85	0.86	0.06	0.90	0.82^{mn}	0.76^{n}	1.00^{m}	0.07	0.03	0.92^{x}	0.96^{x}	0.70^{y}	0.07	0.02
Sweet	0.35	0.36	0.04	0.91	0.35	0.35	0.36	0.05	0.96	0.44^{x}	0.26^{y}	0.36^{xy}	0.05	0.02
Sour	0.67	0.69	0.06	0.64	0.80^{m}	0.73^{m}	0.51^{n}	0.07	<0.01	0.65^{y}	0.53^{y}	0.90^{x}	0.07	<0.01
Salty	0.61	0.59	0.05	0.72	0.49^{n}	0.59^{mn}	0.71^{m}	0.06	<0.01	0.51^{y}	0.75^{x}	0.54^{y}	0.06	<0.01
Bitter	0.54	0.57	0.06	0.66	0.32^{o}	0.53^{n}	0.83^{m}	0.07	<0.01	0.36^{y}	0.92^{x}	0.39^{y}	0.07	<0.01
Burnt	0.34	0.31	0.06	0.68	0.06^{o}	0.28^{n}	0.63^{m}	0.07	<0.01	0.10^{x}	0.80^{y}	0.07^{x}	0.07	<0.01
Buttery	0.61	0.70	0.05	0.24	0.74^{m}	0.72^{m}	0.51^{n}	0.07	0.02	0.76	0.58	0.63	0.06	0.13
Heated Oil	0.07	0.05	0.02	0.31	0.05	0.05	0.08	0.02	0.32	0.06	0.08	0.05	0.02	0.57
Cardboardy	0.44	0.49	0.05	0.44	0.46	0.49	0.45	0.06	0.84	0.44^{y}	0.36^{y}	0.60^{x}	0.06	<0.01
Livery	0.41	0.61	0.07	0.06	0.50	0.55	0.47	0.09	0.80	0.50^{xy}	0.33^{y}	0.71^{x}	0.09	0.01
Green/Hay-Like	0.17	0.25	0.03	0.08	0.20	0.18	0.23	0.04	0.70	0.17	0.16	0.28	0.04	0.07
Earthy/Musty	0.72	0.72	0.05	0.98	0.74^{mn}	0.81^{m}	0.60^{n}	0.06	0.03	0.68^{x}	0.59^{x}	0.89^{y}	0.06	<0.01
Juiciness	8.30	8.30	0.15	0.99	8.81^{m}	8.60^{m}	7.49^{n}	0.18	<0.01	8.51	8.07	8.32	0.18	0.11
MF Tenderness[3]	9.61	9.46	0.18	0.56	10.01	9.52^{mn}	9.08^{n}	0.22	0.01	9.77	9.26	9.57	0.22	0.24
CT Tenderness[3]	9.81	9.60	0.18	0.39	10.07	9.68	9.37	0.22	0.08	9.93	9.41	9.78	0.22	0.22
O Tenderness[3]	9.64	9.45	0.17	0.41	9.97^{m}	9.50^{mn}	9.18^{n}	0.21	0.02	9.77	9.29	9.57	0.20	0.24

[a-b]Means in the same column lacking a common superscript differ due to quality grade (P – Value < 0.05)
[m-o]Means in the same column lacking a common superscript differ due to final temperature (P – Value < 0.05)
[x-z] Means in the same column lacking a common superscript differ due to cook method (P – Value < 0.05)
[1]Attributes were scored using a 15-point numerical scale: 0 = none and 15 = extremely intense.
[2]Standard error (largest) of the least squares means
[3]MF Tenderness = Muscle Fiber Tenderness; CT Tenderness = Connective Tissue Tenderness; O Tenderness = Overall Tenderness

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Table 2. Trained sensory attributes[1] of USDA Select and Upper 2/3 Choice (Top Choice) beef *gluteus medius* cooked to three degrees of doneness using three cook methods.

	Quality Grade				Final Temperature (°C)					Cook Method				
Attribute	Select	Top Choice	SEM[2]	*P*— Value	58.3	70	80	SEM[2]	*P*— Value	Grill	Pan Grill	Oven Roast	SEM[2]	*P*— Value
Beef Flavor ID	6.93	6.95	0.11	0.83	6.82	6.96	7.05	0.12	0.27	6.99^{x}	7.27^{x}	6.56^{y}	0.13	<0.01
Browned	5.85	5.70	0.14	0.29	5.52^{n}	5.62^{n}	6.20^{m}	0.16	<0.01	5.52^{z}	6.20^{x}	5.62^{y}	0.16	<0.01
Roasted	6.75	6.76	0.12	0.94	6.39^{n}	6.82^{m}	7.05^{m}	0.13	<0.01	6.59^{y}	6.53^{y}	7.16^{x}	0.13	<0.01
Bloody/Serumy	0.60	0.66	0.06	0.40	1.18^{m}	0.52^{n}	0.19^{o}	0.07	<0.01	0.75	0.57	0.58	0.06	0.07
Metallic	1.27	1.28	0.06	0.92	1.44^{m}	1.30^{m}	1.10^{n}	0.07	<0.01	1.25	1.27	1.31	0.07	0.82
Fat-Like	0.96	1.06	0.05	0.12	1.28^{m}	0.96^{n}	0.80^{n}	0.06	<0.01	1.17^{x}	1.02^{x}	0.86^{y}	0.06	<0.01
Umami	0.80	0.85	0.05	0.39	0.80	0.81	0.87	0.06	0.58	0.84	0.89	0.74	0.06	0.09
Sweet	0.28	0.22	0.03	0.14	0.27	0.24	0.23	0.04	0.65	0.27^{x}	0.16^{y}	0.31^{x}	0.03	<0.01
Sour	0.86	0.95	0.06	0.25	1.13^{m}	1.02^{m}	0.56^{n}	0.07	<0.01	0.99	0.82	0.90	0.07	0.28
Salty	0.77a	0.63b	0.04	<0.01	0.63	0.71	0.76	0.05	0.09	0.69^{y}	0.82^{x}	0.59^{y}	0.05	<0.01
Bitter	0.70	0.65	0.07	0.78	0.45^{n}	0.67^{mn}	0.87^{m}	0.09	<0.01	0.53^{y}	1.12^{x}	0.35^{y}	0.09	<0.01
Burnt	0.47	0.36	0.09	0.38	0.13^{n}	0.39^{n}	0.72^{m}	0.11	<0.01	0.23^{y}	0.99^{x}	0.02^{y}	0.11	<0.01
Buttery	0.25b	0.34a	0.03	0.04	0.46^{m}	0.21^{n}	0.21^{n}	0.04	<0.01	0.36	0.28	0.24	0.04	0.10
Heated Oil	0.03	0.04	0.01	0.48	0.03	0.03	0.04	0.01	0.67	0.05	0.04	0.02	0.02	0.18
Cardboardy	0.41	0.45	0.04	0.42	0.45	0.44	0.42	0.05	0.90	0.45^{xy}	0.25^{y}	0.51^{x}	0.05	0.03
Livery	0.21	0.23	0.04	0.67	0.28	0.22	0.15	0.04	0.09	0.23^{xy}	0.14^{y}	0.29^{x}	0.04	0.03
Green/Hay-Like	0.23	0.25	0.04	0.68	0.28	0.27	0.17	0.04	0.10	0.26	0.21	0.25	0.04	0.68
Earthy/Musty	0.58	0.54	0.05	0.53	0.62	0.59	0.49	0.06	0.16	0.26	0.56	0.57	0.06	0.99
Juiciness	7.35b	7.78a	0.16	0.03	8.90^{m}	7.52^{n}	6.27^{o}	0.20	<0.01	7.67	7.46	7.56	0.20	0.69
MF Tenderness[3]	8.63	8.59	0.14	0.85	9.63^{m}	8.38^{n}	7.83^{o}	0.17	<0.01	8.73	8.35	8.76	0.17	0.17
CT Tenderness[3]	9.09	9.12	0.15	0.89	10.00	8.76^{n}	8.51^{n}	0.18	<0.01	9.18	8.83	9.30	0.18	0.13
O Tenderness[3]	8.82	8.78	0.13	0.31	9.72^{m}	8.54^{n}	8.14^{n}	0.16	<0.01	8.89	8.55	8.95	0.16	0.15

[a-b]Means in the same column lacking a common superscript differ due to quality grade (P – Value < 0.05)
[m-o]Means in the same column lacking a common superscript differ due to final temperature (P – Value < 0.05)
[x-z] Means in the same column lacking a common superscript differ due to cook method (P – Value < 0.05)
[1]Attributes were scored using a 15-point numerical scale: 0 = none and 15 = extremely intense.
[2]Standard error (largest) of the least squares means
[3]MF Tenderness = Muscle Fiber Tenderness; CT Tenderness = Connective Tissue Tenderness; O Tenderness = Overall Tenderness

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Table 3. Trained sensory attributes[1] of USDA Select and Upper 2/3 Choice (Top Choice) beef *rectus femoris* cooked to three degrees of doneness using three cook methods.

	Quality Grade				Final Temperature (°C)					Cook Method				
Attribute	Select	Top Choice	SEM[2]	*P*— Value	58.3	70	80	SEM[2]	*P*— Value	Grill	Pan Grill	Oven Roast	SEM[2]	*P*— Value
Beef Flavor ID	6.94	6.92	0.11	0.85	6.73^{n}	6.97^{mn}	7.10^{m}	0.13	0.03	6.98^{x}	7.18^{x}	6.64^{y}	0.13	<0.01
Browned	5.47	5.52	0.13	0.73	5.24^{n}	5.36^{n}	5.88^{m}	0.16	<0.01	5.61^{y}	6.41^{x}	4.46^{z}	0.16	<0.01
Roasted	6.93	6.74	0.11	0.08	6.45^{n}	6.91^{m}	7.16^{m}	0.12	<0.01	6.68^{y}	6.73^{y}	7.10^{x}	0.12	<0.01
Bloody/Serumy	0.51	0.60	0.07	0.32	1.01^{m}	0.53^{n}	0.12^{o}	0.09	<0.01	0.59	0.50	0.56	0.08	0.69
Metallic	1.09	1.02	0.06	0.40	1.25^{m}	1.09^{m}	0.82^{n}	0.07	<0.01	1.05	1.01	1.11	0.07	0.49
Fat-Like	0.91b	1.08^{a}	0.06	0.01	1.17^{m}	1.00^{n}	0.81^{o}	0.07	<0.01	1.06^{x}	1.13^{x}	0.80^{y}	0.69	<0.01
Umami	0.75	0.82	0.05	0.21	0.74	0.81	0.81	0.06	0.52	0.73^{y}	0.94^{x}	0.69^{y}	0.06	<0.01
Sweet	0.24	0.29	0.03	0.27	0.29	0.27	0.23	0.04	0.52	0.28	0.22	0.29	0.04	0.32
Sour	0.56	0.63	0.05	0.29	0.69^{m}	0.67^{m}	0.43^{n}	0.06	<0.01	0.61	0.53	0.65	0.06	0.30
Salty	0.74^{a}	0.62^{b}	0.05	0.04	0.55^{n}	0.64^{n}	0.85^{m}	0.06	<0.01	0.63^{y}	0.78^{x}	0.63^{y}	0.06	0.05
Bitter	0.56	0.47	0.06	0.25	0.44^{n}	0.41^{n}	0.69^{m}	0.07	<0.01	0.44^{y}	0.80^{x}	0.29^{y}	0.07	<0.01
Burnt	0.23	0.16	0.06	0.36	0.12^{n}	0.04^{n}	0.41^{m}	0.07	<0.01	0.08^{y}	0.50^{x}	$<0.01^{y}$	0.07	<0.01
Buttery	0.25^{b}	0.40^{a}	0.03	<0.01	0.45^{m}	0.28^{n}	0.23^{n}	0.04	<0.01	0.38^{x}	0.38^{x}	0.20^{y}	0.04	<0.01
Heated Oil	0.04	0.05	0.01	0.38	0.03^{n}	0.02^{n}	0.08^{m}	0.01	0.01	0.06	0.05	0.03	0.01	0.26
Cardboardy	0.41	0.43	0.05	0.79	0.42	0.43	0.41	0.06	0.97	0.37	0.41	0.48	0.06	0.31
Livery	0.21	0.25	0.04	0.53	0.31	0.21	0.18	0.05	0.13	0.18	0.21	0.30	0.05	0.15
Green/Hay-Like	0.19^{b}	0.27^{a}	0.03	0.03	0.28	0.21	0.19	0.03	0.18	0.28^{x}	0.15^{y}	0.25^{x}	0.04	0.01
Earthy/Musty	0.48	0.48	0.04	0.95	0.51	0.52	0.40	0.05	0.09	0.45	0.53	0.45	0.05	0.29
Juiciness	7.23	7.35	0.17	0.56	8.41^{m}	7.64^{n}	5.82^{o}	0.19	<0.01	7.16	7.23	7.49	0.20	0.32
MF Tenderness[3]	8.82	8.68	0.16	0.45	9.28^{m}	8.91^{m}	8.06^{n}	0.18	<0.01	8.52	8.71	9.03	0.18	0.09
CT Tenderness[3]	9.38	9.07	0.12	0.05	9.73^{m}	9.40^{m}	8.54^{n}	0.15	<0.01	9.08	9.14	9.45	0.14	0.13
O Tenderness[3]	9.05	8.82	0.13	0.15	9.42^{m}	9.09^{m}	8.29^{n}	0.15	<0.01	8.75	8.87	9.18	0.15	0.09

$^{a-b}$Means in the same column lacking a common superscript differ due to quality grade (P – Value < 0.05)
$^{m-o}$Means in the same column lacking a common superscript differ due to final temperature (P – Value < 0.05)
$^{x-z}$Means in the same column lacking a common superscript differ due to cook method (P – Value < 0.05)
[1]Attributes were scored using a 15-point numerical scale: 0 = none and 15 = extremely intense.
[2]Standard error (largest) of the least squares means
[3]MF Tenderness = Muscle Fiber Tenderness; CT Tenderness = Connective Tissue Tenderness; O Tenderness = Overall Tenderness

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Table 4. Trained sensory attributes[1] of USDA Select and Upper 2/3 Choice (Top Choice) beef *triceps brachii* cooked to three degrees of doneness using three cook methods.

	Quality Grade				Final Temperature (°C)					Cook Method				
Attribute	Select	Top Choice	SEM[2]	*P*— Value	58.3	70	80	SEM[2]	*P*— Value	Grill	Pan Grill	Oven Roast	SEM[2]	*P*— Value
Beef Flavor ID	7.04	7.12	0.09	0.22	6.94	7.12	7.29	0.12	0.07	7.12^{x}	7.20^{x}	6.85^{y}	0.11	<0.01
Browned	5.63	5.69	0.11	0.69	5.41^{n}	5.55^{n}	6.03^{m}	0.14	<0.01	5.84^{x}	6.42^{y}	4.73^{z}	0.14	<0.01
Roasted	6.83	6.83	0.08	0.99	6.42^{o}	6.90^{n}	7.17^{m}	0.10	<0.01	6.69^{y}	6.69^{y}	7.11^{x}	0.10	<0.01
Bloody/Serumy	0.65	0.62	0.06	0.72	1.21^{m}	0.53^{n}	0.17^{o}	0.07	<0.01	0.71	0.57	0.63	0.07	0.34
Metallic	1.14	1.10	0.05	0.51	1.27^{m}	1.18^{n}	0.90^{o}	0.06	<0.01	1.10	1.11	1.15	0.06	0.67
Fat-Like	1.01^{b}	1.13^{a}	0.04	0.01	1.19^{m}	1.12^{m}	0.89^{n}	0.04	<0.01	1.06	1.07	1.07	0.04	0.95
Umami	0.81^{b}	0.96^{a}	0.05	<0.01	0.81^{n}	0.83^{n}	1.02^{m}	0.06	<0.01	0.92^{x}	0.98^{x}	0.75^{y}	0.06	<0.01
Sweet	0.24	0.28	0.03	0.35	0.27	0.28	0.24	0.04	0.69	0.22	0.24	0.32	0.04	0.11
Sour	0.68	0.68	0.08	0.99	0.88^{m}	0.69^{n}	0.47^{o}	0.09	<0.01	0.67^{xy}	0.57^{y}	0.81^{x}	0.09	0.03
Salty	0.67	0.69	0.04	0.55	0.53^{m}	0.67^{n}	0.84^{o}	0.05	<0.01	0.74^{x}	0.78^{x}	0.52^{y}	0.05	<0.01
Bitter	0.46	0.49	0.05	0.65	0.31^{n}	0.49^{m}	0.64^{m}	0.06	<0.01	0.43^{x}	0.71^{y}	0.29^{x}	0.06	<0.01
Burnt	0.24	0.16	0.05	0.23	0.06^{n}	0.17^{n}	0.38^{m}	0.06	<0.01	0.14^{y}	0.46^{x}	$<0.01^{y}$	0.06	<0.01
Buttery	0.28_{b}	0.40^{a}	0.03	<0.01	0.43^{m}	0.34^{mn}	0.26^{n}	0.04	<0.01	0.35	0.36	0.31	0.04	0.52
Heated Oil	0.05	0.04	0.01	0.28	0.03	0.06	0.06	0.01	0.27	0.04	0.06	0.04	0.01	0.63
Cardboardy	0.50^{a}	0.38^{b}	0.04	0.03	0.46	0.42	0.43	0.05	0.83	0.38^{x}	0.37^{x}	0.55^{y}	0.05	<0.01
Livery	0.22	0.23	0.04	0.98	0.26	0.26	0.16	0.05	0.17	0.17^{y}	0.15^{y}	0.36^{x}	0.05	<0.01
Green/Hay-Like	0.15b	0.28^{a}	0.03	<0.01	0.25	0.24	0.15	0.04	0.09	0.22	0.20	0.23	0.04	0.85
Earthy/Musty	0.43	0.49	0.05	0.29	0.46	0.53	0.40	0.05	0.15	0.47	0.40	0.51	0.05	0.28
Juiciness	7.58	7.86	0.15	0.09	8.82^{m}	7.66^{n}	6.67^{o}	0.17	<0.01	7.56^{y}	7.49^{y}	8.10^{x}	0.17	<0.01
MF Tenderness[3]	8.10^{b}	8.82^{a}	0.14	<0.01	8.94^{m}	8.27^{n}	8.17^{n}	0.17	<0.01	8.56	8.51	8.32	0.17	0.56
CT Tenderness[3]	8.62^{b}	9.22^{a}	0.14	<0.01	9.12	8.85	8.78	0.17	0.31	8.88	9.00	8.88	0.17	0.85
O Tenderness[3]	8.31^{b}	8.97^{a}	0.12	<0.01	8.98^{m}	8.52^{n}	8.43^{n}	0.15	0.02	8.69	8.70	8.54	0.15	0.70

[a-b]Means in the same column lacking a common superscript differ due to quality grade (P – Value < 0.05)
[m-o]Means in the same column lacking a common superscript differ due to final temperature (P – Value < 0.05)
[x-z] Means in the same column lacking a common superscript differ due to cook method (P – Value < 0.05)
[1]Attributes were scored using a 15-point numerical scale: 0 = none and 15 = extremely intense.
[2]Standard error (largest) of the least squares means
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Table 5. Trained sensory attributes[1] of USDA Select and Upper 2/3 Choice (Top Choice) beef *teres major*, roast thickness only, cooked to three degrees of doneness using three cook methods.

	Quality Grade				Final Temperature (°C)					Cook Method				
Attribute	Select	Top Choice	SEM[2]	*P*—Value	58.3	70	80	SEM[2]	*P*—Value	Grill	Pan Grill	Oven Roast	SEM[2]	*P*—Value
Beef Flavor ID	6.92	6.90	0.11	0.90	6.74	6.89	7.11	0.13	0.07	7.20^{x}	6.71^{y}	6.18^{y}	0.13	<0.01
Browned	5.88	5.93	0.13	0.71	5.53^{o}	5.90^{n}	6.27^{m}	0.15	<0.01	6.00^{x}	6.49^{y}	5.24^{z}	0.15	<0.01
Roasted	6.67	6.73	0.14	0.72	6.42^{n}	6.64^{n}	7.04^{m}	0.16	<0.01	6.85^{x}	6.25^{y}	7.00^{x}	0.16	<0.01
Bloody/Serumy	0.74	0.84	0.08	0.23	1.32^{m}	0.79^{n}	0.23^{o}	0.10	<0.01	0.78	0.74	0.82	0.10	0.78
Metallic	1.17^{b}	1.34^{a}	0.06	0.02	1.39^{m}	1.24^{mn}	1.15^{n}	0.07	0.02	1.30	1.28	1.20	0.07	0.47
Fat-Like	1.23	1.22	0.06	0.87	1.44^{m}	1.25^{n}	0.98^{o}	0.07	<0.01	1.34^{x}	1.13^{y}	1.21^{xy}	0.07	0.05
Umami	0.74	0.71	0.06	0.64	0.66	0.73	0.78	0.07	0.39	0.87^{x}	0.59^{y}	0.70^{y}	0.07	<0.01
Sweet	0.25	0.24	0.03	0.84	0.30^{m}	0.26^{mn}	0.18^{o}	0.04	0.04	0.30^{x}	0.17^{y}	0.27^{x}	0.04	0.20.02
Sour	0.61^{b}	1.13^{a}	0.05	<0.01	0.97^{m}	0.95^{m}	0.69^{o}	0.07	<0.01	0.86^{xy}	1.03^{x}	0.72^{y}	0.07	<0.01
Salty	0.75	0.77	0.04	0.78	0.63^{o}	0.76^{n}	0.89^{m}	0.05	<0.01	0.79^{y}	0.59^{y}	0.90^{x}	0.05	<0.01
Bitter	1.05	0.96	0.10	0.52	0.69^{n}	1.13^{m}	1.20^{m}	0.12	<0.01	0.81^{y}	1.88^{x}	0.34^{z}	0.12	<0.01
Burnt	0.94	0.69	0.12	0.15	0.38^{n}	0.96^{m}	1.10^{m}	0.15	<0.01	0.44^{y}	1.99^{x}	$<0.01^{z}$	0.15	<0.01
Buttery	0.38	0.35	0.04	0.60	0.51^{m}	0.37^{n}	0.23^{o}	0.05	<0.01	0.46^{x}	0.31^{y}	0.34^{xy}	0.05	0.05
Heated Oil	0.10	0.07	0.02	0.18	0.08	0.12	0.05	0.02	0.08	0.08	0.10	0.08	0.02	0.54
Cardboardy	0.46^{b}	0.74^{a}	0.06	<0.01	0.65	0.65	0.51	0.07	0.16	0.50^{y}	0.49^{y}	0.82^{x}	0.07	<0.01
Livery	0.26^{b}	0.42^{a}	0.05	<0.01	0.43	0.30	0.29	0.05	0.06	0.31	0.29	0.43	0.05	0.07
Green/Hay-Like	0.20	0.27	0.03	0.05	0.28	0.24	0.18	0.03	0.07	0.22^{xy}	0.17^{y}	0.30^{x}	0.03	0.02
Earthy/Musty	0.52^{b}	0.92^{a}	0.06	<0.01	0.79	0.70	0.67	0.07	0.40	0.60	0.62^{y}	0.94^{x}	0.07	<0.01
Juiciness	8.12	8.43	0.015	0.09	9.10^{m}	8.55^{n}	7.18^{o}	0.17	<0.01	8.21	8.39	8.24	0.17	0.66
MF Tenderness[3]	9.69	9.59	0.16	0.64	10.34	9.54^{n}	9.03^{o}	0.19	<0.01	9.69	9.60	9.62	0.19	0.92
CT Tenderness[3]	10.02	9.99	0.16	0.88	10.56	9.97^{n}	9.48^{o}	0.18	<0.01	10.01	9.82	10.17	0.18	0.32
O Tenderness[3]	9.77	9.68	0.15	0.63	10.32	9.63^{n}	9.23^{n}	0.17	<0.01	9.77	9.62	9.79	0.17	0.71

[a-b]Means in the same column lacking a common superscript differ due to quality grade (P – Value < 0.05)
[m-o]Means in the same column lacking a common superscript differ due to final temperature (P – Value < 0.05)
[x-z] Means in the same column lacking a common superscript differ due to cook method (P – Value < 0.05)
[1]Attributes were scored using a 15-point numerical scale: 0 = none and 15 = extremely intense.
[2]Standard error (largest) of the least squares means
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Table 6. Trained sensory attributes[1] of USDA Select and Upper 2/3 Choice (Top Choice) beef *teres major* 1 inch steaks and roasts cooked to three degrees of doneness using two cook methods.

Attribute	Quality Grade				Thickness				Final Temperature (°C)					Cook Method			
	Select	Top Choice	SEM[2]	*P*—Value	Roast	1 inch	SEM[2]	*P*—Value	58.3	70	80	SEM[2]	*P*—Value	Grill	Pan Grill	SEM[2]	*P*—Value
Beef Flavor ID	7.03	6.95	0.10	0.39	6.98	7.01	0.10	0.75	6.88	6.99	7.11	0.11	0.14	7.05	6.93	0.10	0.20
Browned	6.13	6.14	0.12	0.98	6.26^{m}	6.01^{n}	0.12	0.05	5.84^{t}	6.04^{t}	6.51^{s}	0.13	<0.01	5.94^{y}	6.33^{x}	0.12	<0.01
Roasted	6.51	6.58	0.09	0.54	6.55	6.54	0.09	0.90	6.33^{t}	6.50^{t}	6.81^{s}	0.10	<0.01	6.68^{x}	6.41^{y}	0.09	<0.01
Bloody/Serumy	0.64	0.76	0.06	0.10	0.77	0.63	0.06	0.06	1.16^{s}	0.74^{t}	0.20^{u}	0.07	<0.01	0.74	0.66	0.06	0.32
Metallic	1.11^{b}	1.26^{a}	0.05	<0.01	1.31^{m}	1.07^{n}	0.05	<0.01	1.25	1.21	1.10	0.06	0.09	1.19	1.18	0.05	0.90
Fat-Like	1.24	1.20	0.05	0.53	1.2	1.24	0.05	0.56	1.48^{s}	1.24^{t}	0.95^{u}	0.06	<0.01	1.24	1.21	0.05	0.56
Umami	0.81	0.72	0.05	0.08	0.71^{n}	0.82^{m}	0.05	0.02	0.75	0.75	0.79	0.06	0.77	0.82^{x}	0.71^{y}	0.05	0.03
Sweet	0.25	0.27	0.03	0.60	0.23	0.29	0.03	0.12	0.30^{s}	0.30^{s}	0.18^{t}	0.04	0.02	0.33^{x}	0.19^{y}	0.03	<0.01
Sour	0.60^{b}	1.11^{a}	0.06	<0.01	0.80	0.90	0.06	0.13	0.95^{s}	0.90^{s}	0.71^{t}	0.07	<0.01	0.91	0.79	0.06	0.08
Salty	0.77	0.78	0.04	0.76	0.85^{m}	0.69^{n}	0.04	<0.01	0.65^{t}	0.76^{t}	0.90^{s}	0.05	<0.01	0.72	0.82	0.04	0.04
Bitter	1.08	0.93	0.08	0.15	1.34	0.66	0.08	<0.01	0.69^{t}	1.06^{s}	1.26^{s}	0.10	<0.01	0.69^{y}	1.32^{x}	0.08	<0.01
Burnt	0.90^{a}	0.61^{b}	0.10	0.03	1.22^{m}	0.29^{n}	0.10	<0.01	0.35^{t}	0.82^{s}	1.10^{s}	0.12	<0.01	0.31^{y}	1.20^{x}	0.10	<0.01
Buttery	0.42	0.39	0.03	0.54	0.38	0.43	0.03	0.32	0.56^{s}	0.39^{t}	0.26^{t}	0.04	<0.01	0.43	0.38	0.03	0.27
Heated Oil	0.09	0.06	0.02	0.06	0.09	0.06	0.02	0.21	0.08	0.10	0.05	0.02	0.10	0.06	0.09	0.02	0.12
Cardboardy	0.46^{b}	0.64^{a}	0.05	<0.01	0.50	0.60	0.05	0.09	0.57	0.62	0.46	0.06	0.09	0.57	0.53	0.05	0.51
Livery	0.26b	0.41^{a}	0.04	<0.01	0.31	0.36	0.04	0.25	0.40^{s}	0.36^{s}	0.24^{t}	0.05	0.01	0.35	0.31	0.04	0.38
Green/Hay-Like	0.19	0.25	0.03	0.07	0.20	0.25	0.03	0.16	0.24	0.25	0.17	0.03	0.11	0.24	0.20	0.03	0.22
Earthy/Musty	0.55^{b}	0.83^{a}	0.05	<0.01	0.61^{n}	0.77^{m}	0.05	<0.01	0.76	0.70	0.60	0.06	0.08	0.70	0.68	0.05	0.74
Juiciness	7.81	8.05	8.05	0.11	8.19^{m}	7.76^{n}	0.12	<0.01	8.89^{s}	8.03^{t}	6.87^{u}	0.14	<0.01	7.89	7.98	0.12	0.46
MF Tenderness[3]	9.83	9.82	9.82	0.96	9.63^{n}	10.02^{m}	0.14	0.03	10.72	9.77^{t}	8.99^{u}	0.17	<0.01	9.83	9.82	0.14	0.95
CT Tenderness[3]	10.21	10.21	10.21	0.99	9.90^{n}	10.52^{m}	0.13	<0.01	10.95	10.17^{t}	9.52^{u}	0.15	<0.01	10.24	10.18	0.13	0.70
O Tenderness[3]	9.91	9.91	9.91	0.99	9.67^{n}	10.15^{m}	0.13	<0.01	10.68	9.85^{t}	9.21^{u}	0.15	<0.01	9.95	9.88	0.13	0.64

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$^{m-o}$Means in the same column lacking a common superscript differ due to final temperature (P – Value < 0.05)
$^{x-z}$Means in the same column lacking a common superscript differ due to cook method (P – Value < 0.05)
[1]Attributes were scored using a 15-point numerical scale: 0 = none and 15 = extremely intense.
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[3]MF Tenderness = Muscle Fiber Tenderness; CT Tenderness = Connective Tissue Tenderness; O Tenderness = Overall Tenderness

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